SORGO SILAGE VS GROUND SORGO FOR MILK AND BUTTERFAT PRODUCTION

by

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TABLE OF CONTENTS

	Page
INTRODUCTION	1
REVIEW OF LITERATURE	4
Alfalfa Hay	4
Soy Bean Hay	7
Corn Fodder	9
Sorghum Fodder	10
EXPERIMENTAL PLAN	12
Object of Experiment	12
Method of Computing Rations	12
Duration	13
Cows Used	13
Table I. Descriptive Summary of Cows Used	14
Method of Feeding and Housing	15
Body Weights of Cows	15
Milk Records and Butterfat Tests	15
Feeds Used	16
Composition of Feeds	17
Rations Fed	17
Table II. Relation of Dry Matter Between Silage and Chopped Fodder	18
EXPERIMENTAL RESULTS	18
Feed Consumed	18
Table III. Summary of Feeds Consumed and Change in Live Weights	19
Change in Body Weight	20
Milk and Butterfat Produced	21
Table IV. Live Weights, Feed Consumed, and Milk and Butterfat Production for Lot I	22
Table V. Live Weights, Feed Consumed, and Milk and Butterfat Production for Lot II	23
Table VI. Milk and Fat Production	24
Influence on Butterfat Test	25
Statistical Interpretation of Results	25
Feed for Unit of Production	26
Table VII. Feed Required for 100 Pounds of Four Per Cent Corrected Milk	27
Palatability	28

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Page

COST OF GRINDING 28

SUMMARY OF CONCLUSIONS 29

ACKNOWLEDGMENT 30

BIBLIOGRAPHY 31

APPENDIX

Table VIII. Average Per Cent Composition of Feeds 34

Table IX. Average Per Cent Digestibility of Feed Used 35

Table X. Summary of Per Cent Digestible Nutrients in Feeds 36

Table XI. Digestible Nutrients Fed 37

INTRODUCTION

Along with the development of the dairy cow, from the stage where she was kept only to furnish food solely for her owner to the place she now holds as the source of the leading agricultural industry, has developed new and more profitable methods of maintaining and increasing milk production. Recent years has witnessed a decided increase in the costs of the feeds used for milk production - both concentrates and roughages. With such a condition it is only natural that an effort has been made to increase the efficiency of these feeds. Authorities are agreed that the roughage portion of a ration constitutes the most economical source of nutrients, for the reason that they are produced in such abundance and at a relatively low production cost on the farm. With this condition it is only natural that different means be devised in order to better utilize these farm feed stuffs.

The chopping and grinding of coarse roughages for livestock has been one of the attempts made to better utilize these farm products. Besides the eagerness of the farmers themselves to find improved methods to receive more financial return from their roughage feeds, has come the equal determination on the part of the machinery manufacturers to sell equipment for this purpose. These two

factors have resulted in placing a large number of roughage choppers and grinders on the American farms. This has been brought about in spite of the conflicting evidence presented by experiment stations and farmers in regard to the profitableness of such a practice.

Sorgo, which is produced in large quantities in the lower half of the Mississippi valley, is one of the roughages which lends itself to such processing as chopping and grinding. Kafir, milo, feterita and dura, which are related plants, are also adaptable to such treatment. The combined acreage of these five sorghum crops in the United States was 6,497,000 acres in 1928, (3). Of this amount 2,216,000 acres were harvested as forage. This yielded an average of 2.14 tons per acre, making a total forage crop aggregating 4,740,000 tons.

Kansas ranks third in the production of sorghum crops, being surpassed by Texas and Oklahoma. According to the 1928 figures (2) 1,788,299 acres of sorghum and kafir were grown in the state. From this acreage was harvested 4,592,420 tons of hay, forage and stover which was fed to Kansas livestock. The estimated value of this roughage was $13,521,473. For sorghum forage alone this amounted to 671,220 acres, yielding 2,138,100 tons with a value of $8,007,472.

With such an enormous crop of Sorgo and kafir, it

surely justifies some concern on the part of Kansas farmers as to the proper method of feeding it. Putting this forage in the silo has been held by many as the best method of procedure to follow. It has been contended as being the most economical and convenient method of handling this crop for winter feeding with the advantage of causing little waste. Feeding experiments have more or less substantiated their statements. It has proven to be an ideal method to follow but the big drawback is that there are so few silos in the state. The latest figures (2) show only 13,788 silos in Kansas. This number would not hold 25 per cent of the corn, kafir and sorghum roughage being fed in the state.

With so few silos in use, the suggested lines of procedure to follow are to either build more silos in the state or find some other method of preparing this feed. The poverty of many farmers plus the growing tendency toward more tenancy, has made the building of more silos a slow process. Some progress however, is being made for the figures in 1928 (2) shows 754 more silos than in 1927. The second alternative that is being principally advocated by the machinery manufacturers, is for the farmers to use roughage choppers and grinders. They argue that there is less initial cost and that this processing will make the feed easier to handle, more palatable, more digestible and will result in more economical production than when the

roughage is fed whole.

This experiment on the comparison of Kansas Orange Sorgo silage and ground Kansas Orange Sorgo fodder for dairy cattle, was conducted for the definite purpose of trying to arrive at the answer to this problem which is facing the Kansas farmer. It was contended that if this ground roughage could show favorable results as compared to the proven quality feed, Sorgo silage, that certain general recommendations could be made relative to the grinding of this roughage.

REVIEW OF LITERATURE

A study of the literature relative to the grinding of roughages for dairy cattle reveals a relatively small amount of experimental work on any one feed. If one includes alfalfa, soy beans, corn fodder, and the sorghums it will be found that the smallest amount of work has been done on the sorghums. A brief review of the work done on each of these will serve to demonstrate the general results being secured.

Alfalfa Hay

One of the first works to be published on the digestibility of ground alfalfa hay was made by Forbes and Coworkers in 1925 (11). They reported that the net energy value of alfalfa hay of excellent quality was essentially the same whether coarsely cut or finely ground. On a dry

matter basis the finely ground hay was 2.2 per cent less digestible than the coarsely cut hay. They attributed this difference to a variation in the course of digestion due to rumination. Nevens (22) in 1923 contended that the method of preparation of a feed had little effect on the digestive process. He bases his conclusion on the results secured by examining the stomachs and intestines of slaughtered animals which had been fed on various types of rations.

Beckdel and others of the Pennsylvania station (7) (8) (9) in 1926, 1927 and 1928 reported on the digestibility of the total ration as affected by feeding ground roughages. Ground alfalfa hay was found by them to increase the digestibility of all the constituents with the exception of crude fiber. They also found that 27.0 per cent less time was required for ruminating when ground hay was fed than when fed whole separate from the grain. This observation was made through a window fistula into the rumen.

In 1926 (24) Reed and Burnett of Michigan reported an increase of 0.4 pounds of milk and 0.014 pounds of butter-fat per cow per day where ground alfalfa hay was fed as compared to whole hay. They concluded however, that the grinding of alfalfa for dairy cows was neither profitable nor necessary.

Two feeding trials were conducted at Illinois by Nevens (20) (21), 1926, 1927 to test the practicability of

grinding alfalfa hay for dairy cows. They found that the cows refused 4.3 per cent of the unground, 0.7 per cent of the chaffed and 0.4 per cent of the ground. Hevens concluded from this work that it was doubtful if the gains secured through either chaffing or grinding would cover the cost of power and equipment in grinding.

Rupel and Roche (25),(1927) of Wisconsin Station concluded as a result of two trials that there was no advantage of chopping good quality Wisconsin grown alfalfa.

In 1927 Weaver and others (27) of the Iowa Station published results of an experiment conducted which showed that ground alfalfa was less palatable and produced 4.6 per cent less milk than whole alfalfa. They concluded that the grinding was unadvisable under Iowa conditions.

South Dakota Station (1) states in 1928 that grinding sweet clover or alfalfa decreases the digestibility of the whole ration. They report a slight increase in production due to the grinding but an increase of from three to eleven cents per hundred in the cost of producing the milk.

Morrow and La Master (19) in 1929 report a per cow increase of 0.042 pounds of butterfat and 0.37 pounds of milk a day due to the grinding of alfalfa hay. These results were in line with their digestion trials which showed little difference between the ground and unground hay.

A summary of two years experimental work on ground

alfalfa published in 1929 by Wilbur, Hilton and Mayer of Indiana (28) gave ground alfalfa hay the advantage of 2.5 per cent more milk and 3.4 per cent more butterfat over that produced by unground hay. The change in body weight was almost identical. They concluded that the difference in feeding value did not warrant grinding.

Soy Bean Hay

Due to the large amount of coarse stemmy material in soy bean hay, one would be inclined to assume that it would be benefitted by grinding. Experimental evidence, however, has conflicting views on this point.

Moore and Cowsert (18) 1926, of Mississippi, reported that cows fed ground soy bean hay on a feeding trial ate 74.06 per cent of the amount fed them while those fed the unground ate 62.97 per cent. Those fed unground hay maintained their body weight better and produced slightly more milk and butterfat than did those fed ground hay.

A trial reported by Nevens (21) 1927, of Illinois, gives ground soy bean hay a slight advantage for milk production. He states that there was less waste with the ground hay but that even with these advantages, it was doubtful if the grinding was profitable.

In a report from Maryland (17) 1929, by Ingham and Meade, ground soy bean hay was given an advantage of 1.311 per cent in milk produced, 3.492 per cent in butterfat test

and 4.03% per cent in amount of butterfat produced. Their test also showed 11.07 per cent of the ground hay refused as compared to 69.20 per cent refusal of the unground. Even with a charge of $4.33 per ton for grinding, they found a net gain for the profit for the cows on ground hay of $1.66. This cost of grinding due to the small mill used was admitted to be high, yet they conclude that grinding will pay only in advanced registry work.

Hart (14) 1926, of Wisconsin, reported that the grinding of soy bean hay was unprofitable according to trials run at their station. He said, however, that ground hay gave less waste and increased its feeding value 25 per cent.

An increased production of 0.01 pounds of butterfat and 0.32 pounds of milk a cow per day was found by Morrow and La Master (19) 1929, at the South Carolina Station. The cows receiving ground soy bean hay refused 13.35 per cent less of the amount fed them than did those on whole hay In digestion trials all the nutrients were found to have about the same digestible coefficients with the exception of ash which increased in ground hay 9.8 per cent over that in unground.

Similar trials by Miller and others (25) 1929, at Indiana, favored ground soy bean hay by 3.7 per cent for milk and 5.6 per cent for butterfat production. The change in body weight was almost identical. The increased value of

the grinding they think will not pay for the cost of preparing it.

Hughes of the Maryland Experiment Station (16) 1929, reported a comparison made on ground and unground soy bean hay for milk production where he found a slight increase in both milk and butterfat production on the ground hay. The comparative amounts of the hays refused were 22.2 per cent for unground and 11.07 for the ground. The increase in production was not enough to overcome the cost of grinding.

Corn Fodder

Weaver and others (37) 1927, of the Iowa Station stated that ground alfalfa and corn fodder together when replacing all but 15 pounds of silage, gave them a 2.5 per cent increase in their milk production. They considered this insignificant, however, and concluded that the grinding did not pay.

A refusal of 34 per cent of the uncut stover and a less refusal of the cut stover was reported from the South Dakota Station (1) 1930. They also found that more of the cut stover was eaten, but did not find it economical to prepare it for this slight advantage.

Yo at the Iowa Station (36) 1929, in a comparison of whole fodder with recut fodder found that when whole fodder was valued at $12.00 per ton and the recut at $14.00 per ton that the recut was slightly more profitable. The whole

fodder had 11 per cent more refused by the cows and a 3.4 per cent higher feed cost for the milk produced.

Ogilvie of the same station (25) 1926, compared recut fodder with corn silage. He found that dry matter in corn silage was superior to that in recut fodder for milk and butterfat production. The two proved about equal in maintaining body weight. The silage gave higher net returns and was more palatable.

Fairchild (10) 1929, reported some experiments conducted for a commercial concern in cooperation with farmers in Indiana where he compared the results of whole corn fodder, ground corn fodder and silage. His results indicated that a pound of dry matter in ground fodder was about equal to a pound of dry matter in silage.

An article by Gittins (15) 1930, tells of the increased number of farmers in the corn belt who are using roughage grinders. In chopping corn fodder, he says that many farmers contend that there is less waste, that it requires less storage space and saves hay.

Sorghum Fodder

The Kansas Experiment Station has issued the only reports found covering work done on the relative value of grinding or chopping sorghum fodder. Work reported by the Hays Branch of this station (4) in 1929, compared the rela-

tive value of kafir fodder fed whole, chopped, ground and as silage for beef cattle. The roughage was supplemented by one pound of cottonseed meal per head daily. The same trial was repeated in 1930 (6) and in both cases, they found that the chopped kafir was little better than the whole fodder. The ground kafir fodder however, was much superior and surpassed the silage in the number of pounds gain per ton fed by over 60 per cent. When the yield per acre was considered, it gave silage an advantage of about 60 per cent in 1929 and 90 per cent in 1930 for the amount of gain produced per acre. Their results can be criticised for the reason that they figured their yield per acre while the corn was being ensiled and weighed the amount fed when it was taken from the silo. It would be reasonable to think that much moisture would have escaped after it had been put into the silo.

This review of literature leads one to believe that no definite conclusion can be drawn relative to the general practice of grinding roughage. Harrow and La Master (19) in 1926, demonstrated the divergency of opinion on this point by writing to 57 experiment stations asking for their opinion relative to the advisability of grinding roughage. The answers showed eight with no information or opinion, four with experiments in progress and no opinion expressed, eleven opposed to the practice, eleven neutral or partially

in favor and three favoring the practice.

EXPERIMENTAL PLAN

Object of the Experiment:

The object of this feeding trial was to determine the relative value of large fodder and large silage, when fed on the same dry matter basis for the production of milk and butterfat.

Method of Computing Rations:

The rations for each period were computed according to Henry and Morrison's feeding standards. All rations were adjusted at the beginning of the periods so that each cow received the average between the minimum and maximum amounts of digestible protein and total digestible nutrients. Two cows, (Nos. 64 and 207) were given a little less than the minimum amount of nutrients for the reason that they would not consume more.

The nutrient requirement was determined for the first period by using the average milk production for the five days previous to the beginning of the period, the average test for a two day period taken a week before the period started, and the average weight of the cows taken on the same two days. In the case of the last two periods, the average milk production for the five days preceding each

period, the average test of the previous period, and the average weight of the last three days of the previous period were considered.

Each cow received approximately three pounds of silage (or an equivalent amount of dry matter in some fodder), and one pound of alfalfa hay for each 100 pounds of live weight. Added to this was enough of the grain mixture (4 parts corn, 4 parts bran and 1 part oilmeal) to make up the necessary nutrients.

Duration

Ninety days (Nov. 22, 1929 to Feb. 19, 1930) comprised the time covered by the experiment. This time was divided up into three 30 day periods comprised of an eight day preliminary period and a 22 day experimental period.

Cows Used

Ten cows consisting of three Ayrshires, four Holsteins, two Guernseys and one Jersey from the college herd were used in this experiment. They were divided into two groups as evenly as possible after considering the following factors: breed, age, state of lactation, stage of gestation, daily milk production, butterfat test and weight. Table I presents a comparison of the cows on these points. It will be noted that the groups vary more than desirable in weight and butterfat test. The weight factor could not be remedied due to the limited number of animals available.

Table I. Descriptive Summary of Cows Used

Group	Cow Number	Breed	Age	Weight	Days Lactation	Days in Gestation	Daily milk Production	Per cent Butterfat
I			Yr. Mo.	Lbs.				
	287	Ayrshire	4 - 6	1237	84	Open	30	4.05
	275	Ayrshire	4 -11	1228	41	Open	30	3.1
	160	Holstein	3- 11	1375	47	Open	40	3.9
	161	Holstein	6 -10	1538	319	94	10	4.02
	540	Jersey	5 -10	901	61	Open	22	5.38
II								
	201	Ayrshire	2 - 5	1456	39	Open	20	3.56
	164	Holstein	6 - 2	972	53	Open	30	3.7
	170	Holstein	3 - 7	981	98	Open	35	3.07
	486	Guernsey	2 -11	1210	100	Open	19	4.32
	487	Guernsey	10 - 1	761	91	Open	22	4.07

Method of Feeding and Housing

The cows were fed in the ordinary stanchions of the college dairy barn equipped with experimental feeding mangers. All feeds were weighed to each individual twice daily and any refused portion was weighed back and deducted from the total. The stanchions were equipped with individual drinking cups which kept clean fresh water before each cow at all times. On pleasant days, the cows were allowed to exercise in a dry lot. On such occasions, the cows were out approximately six hours daily.

Body Weights of Cows

Weights of the cows were taken between 7:00 and 8:15 o'clock A.M. on the first and the last three days of each period. The average of the three weights at the beginning were compared with the average of the three weights taken at the end of each period. A comparison of these weights can be found in Tables III, IV and V.

Milk Records and Butterfat Tests

Complete milk records were kept on each of the cows. The cows were milked by hand twice daily. Individual milk samples were taken from each cow for six consecutive milkings as near the center of each period as possible. These were tested by the Babcock test and a true average of the butterfat determined for the period.

Feeds Used

Kansas Orange Sorgo grown on the college dairy farm was used in this experiment. Part of the crop from this certain field was ensiled while part of it was cut with a binder and put into shocks. The fodder remained in shocks until the experiment started at which time it was stored in an open-sided shed. After each treatment, the fodder still retained a high percentage of moisture, as shown in Table II. Portions of fodder were ground in a burr grinder periodically throughout the experiment. It was ground as fine as possible without causing the machine to gum up and clog. This caused much of the Sorgo seed to be crushed although no check was made as to the exact amount. It was difficult to keep this ground Sorgo fodder sealed more than from two to four days during mild winter weather without spoilage.

The alfalfa hay used was grown on the college agronomy farm. It was of good quality, being quite leafy and of a good green color. As compared to the average analyses given in Henry and Morrison's (15), it was quite high in crude protein and a little low in fat. The alfalfa hay was run through a roughage chopper before being fed in order to facilitate weighing and feeding. It was then fed at the rate of one pound for each 100 pounds of live weight.

A grain mixture consisting of four parts corn chop, two

parts wheat bran, and one part old process linseed oilmeal was fed in addition to the roughage. A sufficient quantity of this mixture was fed to supplement the nutrients supplied by the roughage, so that the cows received the necessary nutrients required by the Henry and Morrison standard. One per cent of special steamed bone meal and one per cent of salt was added to the grain mixture.

Composition of Feeds

Composite samples of both hay and grain, and single samples of the silage and ground fodder were taken during each period of the experiment. These were analyzed by the Chemistry Department of the Kansas Agricultural Experiment Station and their results are found in Table VIII of the appendix.

The author conducted moisture tests on the fodder in weekly periods throughout the experimental periods in order to adjust the amounts fed so that the total dry matter fed would be on equitable basis with that fed in the silage. Table II summarizes the findings in this connection.

Rations Fed

The double reversal method of feeding the two groups of cows was used in this trial. They received the feed as follows:

	Period I	Period II	Period III
Lot I	Ground fodder	Silage	Ground fodder
Lot II	Silage	Ground fodder	Silage

Table II. Relation of Dry Matter Between Silage and Chopped Fodder.

Period taken	Per cent Moisture Silage	Fodder	Per cent Dry Matter Silage	Fodder	Per cent of silage wts. used to give equiv. amt. of dry matter in fodder.
I	65.9	48.7	34.1	51.3	66.4
		43.1		56.9	60.0
		45.2		54.7	62.3
II	69.0	45.6	31.0	54.4	58.8
		39.1		60.9	51.1
	67.0	39.6	33.0	60.4	54.7
III	69.0	39.0	31.0	61.0	52.1
		37.9		62.1	52.1
	68.3	38.0	31.7	62.0	52.1
Average	67.8	41.8	32.2	58.2	56.6

EXPERIMENTAL RESULTS

Feed Consumed

A summary of the feed consumed by the two lots of cows for each period is given in Table III. It shows that a total of 3,047 pounds of the grain mixture, 3,023.0 pounds of alfalfa hay, and 8,737.6 pounds of ground fodder were fed to the lots while on the ground fodder ration. On the silage test, they consumed 2,900.3 pounds of the grain mixture, 3063 pounds of alfalfa hay, and 10,022.3 pounds of silage.

Table III. Summary of Feeds Consumed and Change in Live Weights.

Group and Period	Gain or loss in weight	Total Feed Consumed				Per Cow Daily Feed Consumption				Total refused weighed back
		Cotton.	Alfalfa	Silage	Fodder	Cotton.	Alfalfa	Silage	Fodder	
Fodder										
Lot I, Per.I	- 83	1,844	1,306.0		2834.0	11.4	10.6		22.0	0
Lot II, Per.II	-105	961	1,104.0		2078.0	9.0	10.5		19.9	18
Lot I, Per.III	+ 85	819	1,945.0		2825.0	7.3	11.5		18.4	0
Total Fodder	-121	3,047	3,885.0		6737.5	9.24	11.50		20.4	18
Silage										
Lot II, Per.I	- 60	1,970	1,838	3478.0		9.8	11.2	31.2		0
Lot I, Per.II	- 7	1,025	1,838	3717.5		9.1	11.3	30.8		67
Lot II, Per.III	+ 47	879.5	1,167.5	3400.0		7.9	10.7	31.7		4
Total Silage	- 40	3,960.5	3,683.	10595.5		8.97	11.16	32.56		71

When figuring each lot separately, we find that Lot I consumed an average of 1023 pounds of the grain mixture, 1224.5 pounds of alfalfa hay and 2329.5 pounds of ground fodder for the two periods on the fodder ration. On silage for the one period, they consumed 1005 pounds of the grain mixture, 1258 pounds of alfalfa hay, and 5,717.5 pounds of silage.

Lot II consumed 921 pounds of concentrates, 1194.0 pounds of ground fodder for its one period on the fodder ration. During the two periods on silage, they consumed an average of 973.7 pounds of concentrates, 1239.7 pounds of alfalfa hay and 5553.5 pounds of silage.

Table XI (appendix) gives the number of pounds of dry matter and digestible nutrients fed to each lot for each period. This indicates that Lot I received an average of 2215 pounds of digestible nutrients for the two periods they were on ground fodder and 2067.4 pounds while on silage. Lot II is credited with consuming 2315.4 pounds of digestible nutrients while on ground fodder and an average of 1965.6 pounds for the two periods on silage. Both lots according to the calculation made, received slightly more digestible nutrients on ground fodder than when on silage.

Change in Body Weight

The changes in body weight of the two lots of cows can be found in Table III. The total weight lost while on fodder

for both groups was 191 pounds, while silage caused a loss of 40 pounds. A comparison by taking each lot separately (Tables IV and V) shows that Lot I lost an average of 9 pounds per period on silage and 7 pounds per period on ground fodder. Lot II shows a loss of 105 pounds while on ground fodder and 16.5 pounds average loss for the two periods on silage. These figures do not indicate that there is a great deal of difference between Sorgo silage and ground Sorgo fodder in maintaining live weight. The little difference that does exist in favor of the silage could easily be accounted for in experimental error due to the variation in the fill of the animals at the time they were weighed. Marked variations were noted in this respect by Armsby (6).

Milk and Butterfat Produced

Tables IV and V show a comparison of the individual lots on both feeds. Lot I produced an average of 3173.3 pounds of milk and 123.223 pounds of butterfat for its two periods on ground fodder and 3599.9 pounds of milk and 113.433 pounds of butterfat while on silage.

Table IV. Live Weights, Feed Consumed, and Milk and Butter Fat Production for Lot I.

Ration	Cow No.	Change in live weight	Total Feed Cons. Grain mix.	Alfalfa hay		Total Production Milk	Fat
I.					Fodder		
Ground	267	-32	330	286	518	1,084.5	35.779
Fodder	275	-16	308	264	518	915.1	33.631
	160	+ 6	330	308	601	987.1	30.756
	161	-12	88	308	606	988.9	13.220
	345	- 4	198	220	859	640.5	23.536
Total or Ave.		-33	1,254	1,386	3,102	3,576.1	136.962
II.					Silage		
Silage	267	+22	264	264	732	948.3	32,646
	275	00	286	264	732	876.0	27,614
	160	+ 8	320	308	984	881.4	24.190
	161	-46	70	196	615.5	851.5	8.244
	345	+ 8	154	220	804	542.8	20.821
Total or Ave.		- 7	1,003	1,252	3,717.5	2,899.9	113.433
III.					Fodder		
Ground	267	+22	264	264	418	928.3	29.241
Fodder	275	+25	220	264	418	613.4	27.300
	160	- 6	154	308	434	571.5	24.490
	161	+16	86	209	397	225.7	9.403
	345	+ 6	88	198	306	532.8	19.029
Total or Ave.		+65	812	1,243	2,025	2,772.5	109.471
Summary							
Fodder Ave. I & III		- 9	1,033	1,315.5	2,563.5	3,173.8	123.226
Silage Per.II		- 7	1,003	1,252.0	3,717.5	2,899.9	113.433
Increase on Fodder			30	63.5		273.9	9.793
Increase on Silage		2			1,154.0		

Table V. Live weights, Feed Consumed, and Milk and Butter Fat Production for Lot II.

Ration	Cow No.	Ave. live weight	Total Feed Cons. Grain mix.	Alfalfa hay		Total Production Milk	Fat
I.					Silage		
Silage	164	- 7	330	330	836	1,440.4	51.149
	201	-37	198	220	660	823.8	21.991
	427	-13	198	198	616	497.2	21.284
	179	+ 1	220	209	836	718.4	24.741
	465	-24	132	198	880	395.6	19.405
Total or ave.		-80	1,078	1,255	3,476	3,885.3	139.310
II.					Fodder		
Ground	164	-25	330	532	396	1,301.7	45.770
Fodder	201	-28	154	220	495	585.3	25.307
	427	-57	176	198	363	410.7	16.109
	179	+ 6	189	242	457.8	606.5	20.476
	465	+11	132	176	324	349.1	17.245
Total or Ave.		-103	981	1,196	2,073.8	3,819.3	122.914
III.					Silage		
Silage	164	+ 2	307.5	389.5	891	1,130.7	36.770
	201	-13	176	220	660	533.4	21.117
	427	+16	154	198	594	345.2	14.819
	179	+10	154	264	792	536.5	19.827
	465	+24	88	176	528	350.6	10.807
Total or Ave.		+47	879.5	1,187.5	3,495	2,896.6	111.330
Summary							
Silage Ave. I & III		16.5	978.7	1,209.7	3,485.5	3,265.8	125.320
Fodder Per.II		-106	981.0	1,196.0	2,073.8	3,819.3	122.914
Increase on Silage		86.5		15.7	1,407.8	46.5	2.406
Increase on Fodder			2.5				

This gives ground fodder an advantage of 573.9 pounds of milk and 9.793 pounds of butterfat.

Lot XI produced 3819.3 pounds of milk and 122.914 pounds of butterfat for its period on ground fodder and 3365.8 pounds of milk and 125.52 pounds of butterfat as an average for the two periods on silage. The silage in this case received the advantage by 46.5 pounds of milk and 2.406 pounds of butterfat.

As is shown in Table VI, the two lots while on ground fodder produced a total of 9565.9 pounds of milk and 369.388 pounds of butterfat. On silage the total production was 9451.5 pounds of milk and 364.974 pounds of butterfat. This shows a difference in favor of the ground fodder of 0.41 pounds of milk and 0.016 pounds of butterfat a cow per day.

Table VI. Milk and Fat Production.

Group and Period	Milk Production Total	Milk Production Daily	Fat Production Total	Fat Production Daily	Average Test
Fodder					
Lot I, Per. I	3373.1	32.39	136.982	1.346	3.331
Lot II, Per.II	3819.3	29.26	122.914	1.117	3.618
Lot I, Per.III	2772.5	25.20	109.471	0.995	3.949
Total	9965.9	28.99	369.388	1.119	3.900
Silage					
Lot II, Per. I	3665.9	35.318	139.310	1.266	3.801
Lot I, Per.II	2899.9	26.36	113.433	1.651	3.911
Lot II, Per.III	2886.6	26.06	111.350	1.051	3.933
Total	9451.5	28.900	364.074	1.103	3.900

Influence on Butterfat Test

Table VI shows that an average test of 3.330 per cent was shown as the average butterfat test for the two lots while on each ration. A comparison within each lot shows that Lot I averaged 3.382 per cent on ground fodder and 3.311 per cent on silage -- a difference of 0.070 per cent in the butterfat percentage in favor of silage.

Lot II averaged 3.325 per cent on silage and 3.218 per cent on fodder or a difference of 0.107 per cent in favor of the silage. This comparison gives a slight advantage to silage in maintaining the butterfat test. With the test taken during only three days of each period, it is reasonable to assume that this slight difference is insignificant.

Statistical Interpretation of Results

The daily milk production per cow was arranged in frequency tables - the silage fed daily production in one table and the ground fodder results in the other. A class interval of two was used, ranging from two pounds up to 70 pounds.

The means, thus computed gave 29.0181 $\pm$ .3504 pounds of milk per cow per day for the fodder group and 28.850 $\pm$ .3333 pounds for the silage group. The difference between the means equals 1.168 with a probable error of the difference between the two means of .3807. When 1.168, the difference

between the two means, is divided by its probable error of .0307 the result is 2.931. This interpreted, means that according to the law of chance that a deviation as great as or greater than this will occur 15.75 times out of 100 trials. Such results are not considered to be a significant difference, according to statisticians.

Feed for Unit of Production

Table VII gives the pounds of four per cent equivalent milk produced as computed by the formula worked out by Gaines (14) along with the amount of the various feeds required to produce 100 pounds of this milk. The number of pounds of ground fodder and silage were computed to a dry basis in order to give an equitable comparison. The results summarized show that the ground fodder ration required 32.82 pounds of concentrates, 40.81 pounds of alfalfa hay and 40.77 pounds of fodder dry matter to produce 100 pounds of 4 per cent equivalent milk. On silage it required 32.06 pounds of concentrates, 30.30 pounds of alfalfa hay, and 39.72 pounds of silage dry matter to produce this amount of milk. This comparison shows that the feed requirement for 100 pounds of milk was very nearly alike on both feeds.

Table VII. Feed Required for 100 Pounds of 4 Per Cent Fat Corrected Milk.

Group and Period	lbs. of 4% fat corrected milk* Total	Daily	Feed required for 100# of Corrected 4% milk* Concen.	Alfalfa	Chopped fodder	lbs. dry matter ** (fodder)
Fodder						
Lot I, Per. I	3484.77	31.97	36.38	38.77	75.53	41.05
Lot II, Per. II	3131.43	28.46	31.82	36.18	68.37	38.28
Lot I, Per. III	2751.00	25.00	29.51	45.18	75.69	45.41
Total	9367.20	85.32	32.62	40.31	70.05	40.77
Silage					Silage	Silage
Lot II, Per. I	3555.65	32.32	30.31	34.64	97.75	33.33
Lot I, Per. II	2341.45	26.01	35.05	45.76	120.77	41.32
Lot II, Per. III	3216.69	25.60	31.32	42.16	124.03	38.23
Total	9236.69	27.90	32.06	39.86	115.75	39.72

*Corrected on energy value basis - Formula (0.4 x lbs. milk)+(15 x lbs. Fat)(14)
**Figured from average of moisture tests taken each period.

Palatability

During the course of the experiment, very few irregularities were noted. The ground fodder when fed on the same dry matter basis as silage was relished by the cows. As compared to the analysis given for cane fodder in Henry and Morrison's (15) the ground fodder with its average moisture content of 61.6 per cent was exceptionally high but according to the Chemistry Department, it is about normal for Kansas Orange.

Table III presents a period summary of the amounts of feed weighed back from the cows. It shows that a total of 18 pounds was refused by the cows while on ground fodder and 72 pounds while on the silage ration. This small amount of refused feed for each ration seems to indicate that the palatability of the feeds was about the same.

COST OF GRINDING

The Department of Agricultural Engineering cooperated in the running of this trial by grinding the fodder. A small burr mill was used in the grinding. Their results indicate that the smaller mill was just as economical with power in the grinding of the fodder as was found with the larger mills at the Hays Experiments (4) and (6). In the case of this trial where only five cows were fed the ground fodder, the labor cost figured to be about one-half more.

Their results are not intended to be exclusive and were only conducted in order to get a relative value of the cost on a smaller mill as compared to a larger one. The average cost found would range between $1.22 and $1.40 per ton.

SUMMARY AND CONCLUSIONS

1. The total milk and butterfat production for Lot I was 273.9 pounds of milk and 9.785 pounds of butterfat per period in favor of ground fodder. Lot II gave 46.5 pounds more milk and 2.403 more pounds of butterfat per period while on silage than on ground fodder. These differences seem to balance each other within the limit of experimental error.

2. Ground Sorgo fodder and Sorgo silage when fed on the same dry matter basis were found to be about equal in maintaining body weight. The total loss on the silage ration was 40 pounds, while 121 pounds loss in weight was noted on the ground fodder.

3. The butterfat percentage varies very little between the two feeds. Lot I averaged 0.039 per cent higher while on silage while an increase of 0.107 per cent was noted for Lot II when on silage.

4. A statistical interpretation of the results showed that the difference in the milk production was not significant. The difference between the means thus computed was

1.186 ± 0.3803. This difference divided by its probable error is 3.981, while it should equal 3.0 to 4.9 to be really significant.

5. The amount of feed necessary per unit of production was found to be approximately equal for the two rations.

6. The cost of grinding which averaged from $1.22 to $1.40 per ton on the small mill used was as economical of power as that reported for large mills but the labor cost was more.

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BIBLIOGRAPHY

1. Anonymous, 1928: Grinding Roughage for Dairy Cattle. So. Dak. Ag. Exp. Sta. Annual Report 1924 :15.

2. Anonymous, 1928: Biennial Report of the Kansas State Board of Agriculture, 1927-1928.

3. Anonymous, 1928: Yearbook of U. S. Department of Agriculture 1928 :736.

4. Anonymous, 1929: Comparative Value of Kafir Fodder Fed in Different Forms. 17th Annual Cattlemen's Round-up, Fort Hays Branch of Ks. Ag. Exp. Sta. Report 1929.

5. Anonymous, 1930: Comparative Value of Kafir Fodder Fed in Different Forms. Kansas Report of 18th Annual Cattlemen's Round-up, Fort Hays Branch of Ks. Ag. Exp. Sta. 1930.

6. Armsby, H. P., 1928: The Nutrition of Farm Animals. The Macmillian Company, New York p.197.

7. Beckdel, A. L, 1926 and associates: 36th Annual Report of Penn. Ag. Exp. Sta. 1925-1926, Penn. Ag. Exp. Sta. Bul. 204:18.

8. Beckdel, A. L., 1927 and Associates: 40th Annual Report of Penn. Ag. Exp. Sta. 1926-1927, Penn. Ag. Exp. Sta. Bul.213:18.

9. Beckdel, A. L., and Williams, P. S., 1929: Digestibility of Total Ration as Effected by Grinding Roughage. Penn. Ag. Exp. Sta. Bul.230 (Annual Report 1927-28).

10. Fairchild, L. H., 1929: Why Not Grind Roughage. Kansas Farmer 67, No.41 p.7,21.

11. Forbes, E. B., and others, 1926: Net Energy Value of Alfalfa Hay and Alfalfa Meal. Journal Ag.Research 31:967-998.

12. Gaine, W. L., 1928: The Energy Basis of Measuring Milk Yield in Dairy Cows. Ill. Ag. Exp. Sta. Bul. 303:434.

13. Gittins, S. A.,: Does Roughage Chopping Pay? Successful Farming 26:17, 65.

14. Hart, E. B., 1923: Wis. Ag. Exp. Sta. Bul.353:127-151.

15. Henry, W. A., and Morrison, F. B., 1923: Feeds and Feeding. 19th Edition 700-745.

16. Ingham, L. S., 1923: Ground vs. Unground Soybean Hay. Board's Dairyman 75:1035.

17. Ingham, L. S., and Meade, De Vos, 1929: Ground vs. Unground Soybean Hay for Dairy Cattle. Maryland Ag. Exp. Sta. Bul. 316:224-229.

18. Morse, J. S., and Conaert, P. O., 1920: Soybeans for Dairy Cows. Miss. Ag. Exp. Sta. Bul.236:10-11.

19. Morrow, R. S., and Le Master, J. F., 1923: Ground Hay for Milk Production. So. Carolina Ag. Exp. Sta. Bul. 255:1, 11-21.

20. Stevens, W. B., 1926: A Year's Progress in Solving Some Farm Problems in Illinois. Ill. Ag. Exp. Sta. Annual Report 1925-1926:89-90.

21. Stevens, W. B., 1927: A Year's Progress in Solving Farm Problems in Illinois. Ill. Ag. Exp. Sta. Annual Report 1926-1927:185-190.

22. Stevens, W. B., 1928: Effect of Fasting and the Method Preparation of Feed upon the Digestive Process in Dairy Cattle. Jour. Ag. Research 36:773-794.

23. Upliv, A. E., 1929: The Value of Mount Corn Fodder and Corn Silage for Dairy Cows. Thesis for M. S. Degree at Iowa State College.

24. Wood, O. E., and Barnett, J. E., 1926: Ground Alfalfa for Dairy Cows. Quarterly Bul. Mich. Ag. Exp. Sta. Bul. 9, No.1, p. 3-5.

25. Rupel, I. W., and Weaks, B. H., 1927: Chopping Hay for Dairy Cattle. Annual Report Wis. Ag. Exp. Sta. Bul. 396:29-30.

26. To, S. T., 1929: A Comparison of Shout Corn Fodder with Whole Corn Fodder for Feeding Dairy Cows. Thesis for M. S. Degree, Iowa State College.

27. Weaver, Earl; Kiy, Fordyce; and Matthews, C. A., 1927: Grinding Roughage for Dairy Cattle. Iowa Ag. Exp. Sta. Leaflet No. 70.

28. Wilbur, J. W., Hilton, J. H., and Hayes, I. D., 1923: The Value of Grinding Feeds for the Dairy Ration, Part II, Purdue Univ. Stencil Bul. No. 4.

APPENDIX

Table VIII. Average Per Cent Composition of Feeds.

Feed	Moisture	Crude Prot.	Fat	Crude Fiber	Ash	N.F.E.*	Acidity
Period I							
Grain mixture	10.43	15.44	4.31	4.90	6.17	58.75	-----
Alfalfa hay	6.22	17.56	1.60	28.84	8.41	37.37	-----
Sorgo silage	68.83	2.07	0.72	6.42	1.81	20.15	2.24
Gr. fodder	45.70	2.05	1.23	11.34	2.86	36.80	0.24
Period II							
Grain mixture	10.89	14.50	3.98	4.70	5.81	60.12	-----
Alfalfa hay	13.59	17.95	1.62	22.72	9.99	34.07	-----
Sorgo silage	68.20	2.02	0.75	6.84	1.89	20.30	2.24
Gr. fodder	41.43	3.24	1.54	12.41	3.34	38.01	0.18
Period III							
Grain mixture	10.34	14.50	4.06	3.94	6.30	60.86	-----
Alfalfa hay	15.50	16.99	1.36	23.95	9.03	33.17	-----
Sorgo silage	68.30	1.91	0.78	6.83	1.81	20.37	-----
Gr. fodder	38.30	2.43	1.49	13.99	3.67	40.12	-----

* N.F.E. Nitrogen Free Extract

Table IX. Average Per Cent Digestibility of Feeds Used.

Feed	Dry matter	Crude Protein	Carbohydrates Fiber	Carbohydrates Nitrogen Free Ext.	Fat
Grain mixture*	81.0	77.2	48.8	85.1	84.4
Alfalfa	60.0	71.0	43.0	72.0	38.0
Sorgo silage	57.0	40.0**	58.0	64.0	56.0
Sorgo fodder	58.0	38.0	61.0	63.0	65.0

* Calculated by taking four times the coefficient of digestibility of corn plus two times the coefficient of digestibility of bran plus the coefficient of digestibility of linseed oilmeal, and the result divided by seven. (Taken from Henry and Morrison, 1923, Appendix II) (17).

** Not given in Table II but calculated from Tables I and III of Henry and Morrison (17).

Table X. Summary of Per Cent Digestible Nutrients in Feeds*

Feed	Total Dry matter	Crude Protein*	Carbo-hydrates Fiber	Carbo-hydrates N.F.E.	Fat*	Total Dig. Nutrients
Period I						
Grain mixture	89.57	11.92	2.39	50.00	3.64	72.60
Alfalfa	93.78	12.47	12.40	26.90	0.61	53.14
Sorgo silage	31.17	0.33	3.72	12.90	0.40	18.35
Sorgo fodder	54.30	0.78	6.92	23.18	0.80	32.68
Period II						
Grain mixture	89.11	11.19	2.99	51.16	3.36	72.30
Alfalfa	86.41	12.74	9.80	24.53	0.62	48.46
Sorgo silage	31.80	0.61	3.97	12.99	0.42	18.71
Sorgo fodder	58.57	1.23	7.57	23.95	1.00	35.00
Period III						
Grain mixture	89.66	11.19	1.92	51.79	3.43	72.61
Alfalfa	84.50	12.06	10.30	25.88	0.52	47.41
Sorgo silage	31.70	0.76	3.96	13.04	0.44	18.75
Sorgo fodder	61.70	0.92	8.53	25.26	0.83	36.58
Average for three periods:						
Grain mixture	89.44	11.43	2.20	50.99	3.48	72.45
Alfalfa	88.23	12.42	10.83	25.10	0.58	49.68
Sorgo silage	31.55	0.90	3.88	12.98	0.42	18.60
Sorgo fodder	58.64	0.98	7.66	24.32	0.88	34.94

* Computed from actual analyses given in Table VIII and digestible coefficients given in Table IX.

Table XI. Digestible Nutrients Fed*

Feed	Pounds fed	Dry matter	Digest. crude Protein	Total digestible nutrients
Period I (Fodder Group) Lot I.				
Grain mixture	1254.0	1123.2	149.5	909.2
Alfalfa	1386.0	1299.8	172.8	736.5
Sorgo fodder	2634.0	1430.2	20.5	860.8
Total		3853.2	342.8	2506.5
Period I (Silage Group) Lot II.				
Grain mixture	1078.0	965.6	128.5	781.5
Alfalfa	1232.0	1155.4	153.6	654.7
Sorgo silage	3476.0	1083.5	27.8	637.8
Total		3204.5	309.9	2074.0
Period II (Fodder Group) Lot II.				
Grain mixture	981.0	874.2	109.8	709.3
Alfalfa	1194.0	1031.7	152.1	573.6
Sorgo fodder	2078.5	1217.4	25.5	727.5
Total		3123.3	287.4	2015.4
Period II (Silage Group) Lot I.				
Grain mixture	1003.0	893.8	112.2	725.2
Alfalfa	1252.0	1081.9	159.5	606.7
Sorgo silage	3717.5	1182.2	30.1	695.5
Total		3157.9	301.8	2027.4
Period III (Fodder Group) Lot I.				
Grain mixture	812.0	728.0	90.9	589.6
Alfalfa	1243.0	1050.3	149.9	589.3
Sorgo fodder	2025.0	1249.4	18.6	740.7
Total		3027.7	259.4	1919.6
Period III (Silage Group) Lot II.				
Grain mixture	879.5	788.6	98.4	638.6
Alfalfa	1187.5	1003.4	143.2	563.0
Silage	3495.0	1107.9	26.6	655.3
Total		2899.9	268.2	1856.9

*Computed from actual amounts fed and Table X.